

NOTES ON THE *CICINDELA PRÆTEXTATA* -
CALIFORNICA TIGER BEETLE COMPLEX.
DESCRIPTION OF A NEW SUBSPECIES
FROM DEATH VALLEY, CALIFORNIA
(COLEOPTERA - CICINDELIDÆ)

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This is written for the purpose of contributing further data to our growing knowledge of the Southwestern United States tiger beetles. This study attempts to establish a more fundamental systematic separation between *Cicindela prætextata* and *Cicindela californica* as it redefines the distribution of these species. At the subspecific level the following is proposed:

1. That the tiger beetle described as *Cicindela californica erronea* Vaurie (1950 : 8) from Willcox, Arizona, and the very similar tiger beetle discovered in Death Valley, California (Rumpp 1956 : 131) are not the same; that, in fact, they are allopatric siblings that belong to separate species. This conclusion is based in part on differences in the primary sexual characters of the internal sac of the male copulatory organ.

2. That the Death Valley tiger beetle is a new subspecies of *Cicindela californica* to be known henceforth as ***Cicindela californica pseudoerronea***, new subspecies.

3. That the Willcox tiger beetle is not a subspecies of *Cicindela californica*, as reported, and should be known henceforth as *Cicindela prætextata erronea* Vaurie, new combination.

ACKNOWLEDGMENTS

Many thanks are due Dr. Mont A. Cazier for the donation of samples of ssp. *erronea*, including a paratype, and the exchange of valuable information. Sincere appreciation is expressed for the kind assistance of Mr. Lloyd M. Martin of the Los Angeles County Museum in arranging for the loan of material. Mr. Hugh B. Leech of the California Academy of Sciences supplied specimens and loaned important literature for which the author is grateful.

HISTORICAL BACKGROUND

C. californica Ménériés 1854, and *C. prætextata* LeConte 1854 were described in the same year as separate species. When LeConte wrote his revision of the Cicindelæ (1857: 27-62) he considered *C. prætextata* and *C. circumpecta* as closely allied species, but completely misplaced the relationship of *C. californica* because he had only seen a sketch of the latter's elytral maculation. C. W. Leng

(1902: 171-172) in his review of the Cicindelidae chose to include both under *C. circumpicta*, basing his decision on superficial characters common to all three. T. L. Casey in his Memoirs (1913: 11, 33) thought these were distinct species, however his knowledge of *C. californica* seems to have been very limited. W. Horn in his checklist of the Cicindelidae (1930) made allowance for specific differences between *C. californica* and *C. circumpicta*, but maintained that *C. praetextata* was a "lesser form" of *C. californica*. It was not until recently that M. A. Cazier (1954: 288) reported reproductive isolation between *C. praetextata* and *C. californica*, establishing from this observation the first proof of specific difference. Today *C. californica* and *C. praetextata* are accepted as distinct species; though some confusion still exists at the subspecific level.

At the time ssp. *erronea* was described *praetextata* was still considered subspecific to *C. californica*, which necessitated placing *erronea* under that species. In the original literature (Vaurie 1950: 1) the dissimilarity — rather than the close relationship — between ssp. *erronea* and ssp. *praetextata* was brought out. A bright green and blue tiger beetle discovered in Death Valley, California, in 1954 was recorded as equivalent to ssp. *erronea* (Rumpp 1956: 131). It will be shown that these conclusions are erroneous, and this, by coincidence, makes the name of the tiger beetle even more appropriate than originally intended.

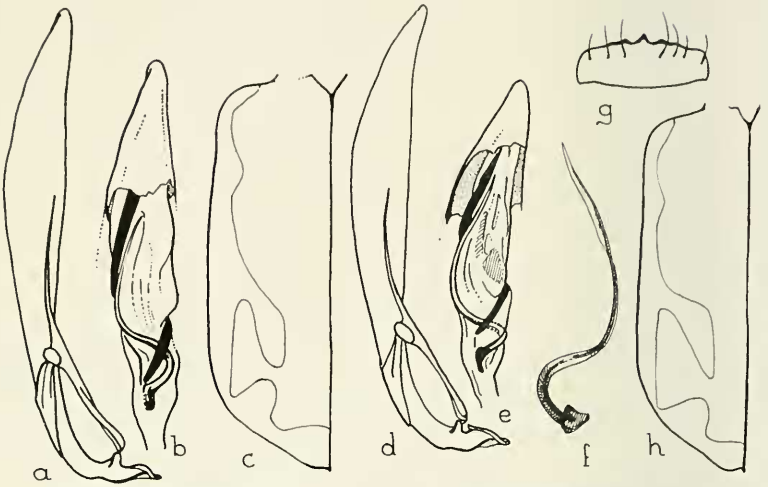
ORIGIN, SEPARATION AND DISTRIBUTION

The work of E. Rivalier (1950: 217-244) and Helga Papp (1952: 492-533) on the Cicindelae demonstrates clearly that the internal sac of the male copulatory organ can be used effectively as a positive classification factor. In a later paper on the American fauna (1954: 249-268) Rivalier indicates that *C. californica* and *C. circumpicta* can be grouped under the *Habroscelimorpha* Dohktourow, of which *C. dorsalis* is the type species.

The internal sacs of *C. praetextata* and *C. circumpicta* are of similar design and closely related to the *dorsalis* type. The rather long sac is encircled by a flagellum that traces a short clockwise whorl or loose spiral from the dorsal side¹ where it originates to the ventral side, thence another 90 degrees at the upper half where it sustains a membrane. This flagellum is fairly short, falciform, flattened into a ribbon at the lower half, and slightly expanded in the spiral that it describes from the ventral side to its base; this is illustrated on Plate 31, fig. f.

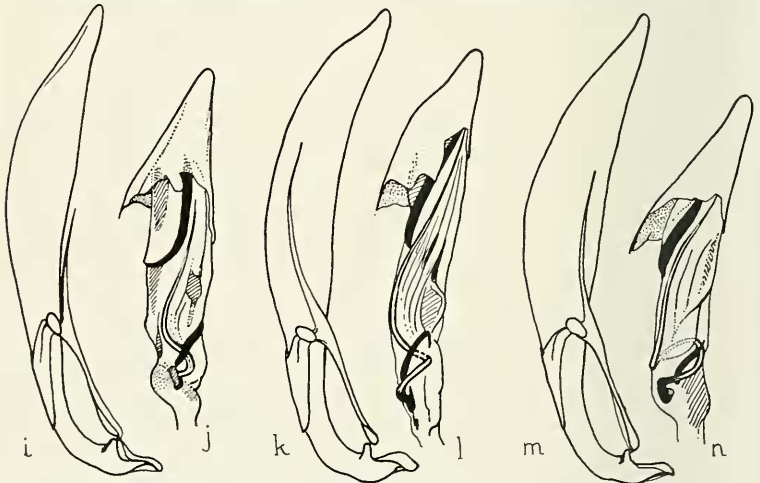
The internal sacs of *C. californica* and the related western species *C. gabbi* are of the same elongated form. In these the flagellum is

¹ The dorsal side of the penis is defined as the side that is viewed from the dorsal side of the insect when the elytra are parted, and when the penis is retracted within the body.



C. PRÆTEXTATA PRÆTEXTATA LeC.

C. PRÆTEXTATA ERRONEA Vaurie



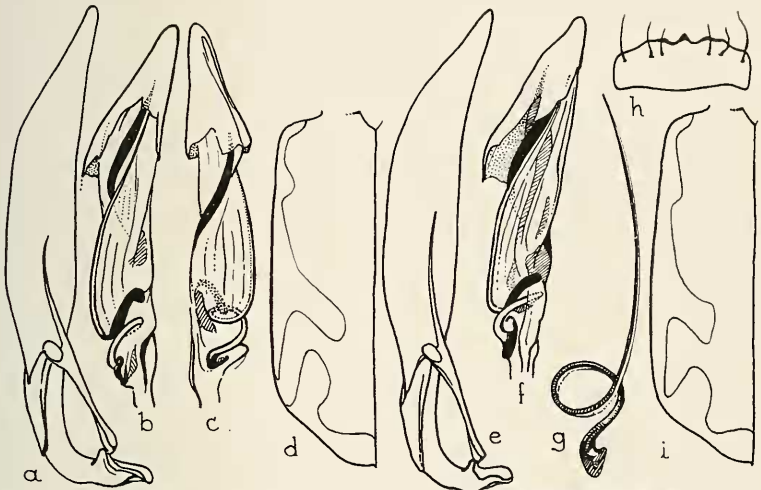
C. DORSALIS DORSALIS Soy

C. CIRCUMPICTA JOHNSONI Fitch

C. GABBI G. Horn

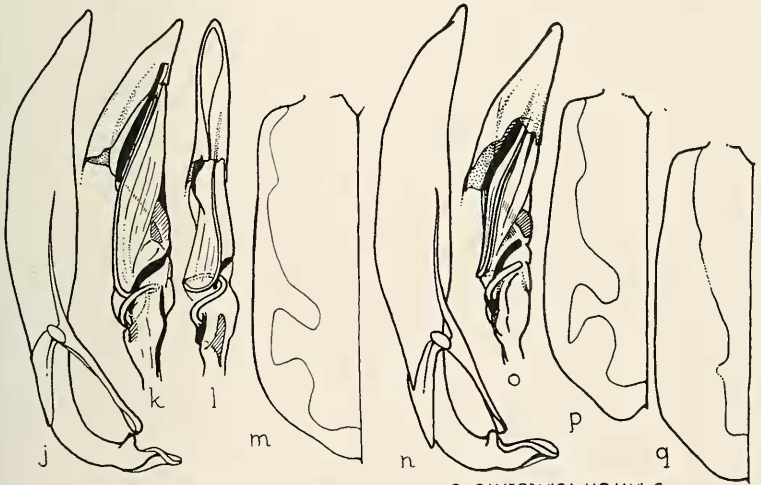
PLATE 31

Cicindela prae-textata group compared to other allied *Cicindela*. Male copulatory organ, internal sac, and elytral marking. Figs. f. and g. of flagellum and labrum of *C. prae-textata erronea*.



C. CALIFORNICA CALIFORNICA Mén.

C. CALIFORNICA PSEUDOERRONEA n. sp.



C. CALIFORNICA BREVIHAMATA W. Horn

C. CALIFORNICA MOJAVI Caz.

PLATE 32

Cicindela californica subspecies—Male copulatory organ, internal sac, and elytral marking. Figs. g. and h. of flagellum and labrum of *C. californica pseudoerronea*.

much longer, and more intricate in that it makes a complete loop that encompasses well over 360 degrees. The loop, while helicoidal, is nearly perpendicular to the axis of the sac, as shown on Plate 32, fig. g. There is only a slight flattening of the flagellum near its base. This structural specialization of the flagellum is so atypical as to have originated before the Pleistocene period; possibly at a time when important geological changes effectively separated these species from the main ancestral group.

Many of the Southwestern tiger beetles have varying numbers of subspecies that have developed as a result of relatively rapid changing environmental conditions. These conditions were particularly accelerated during the Pleistocene period. Following the various glacial advances there were post-pluvial times during which a steady drying up of the available surface water of the region caused disrupted concentrations around which some species had to readjust. Complex changes in the hydrographic connections between systems had a deep effect on the ecology of these species. In attempting to adjust to all these changes the isolated populations developed variations in color, maculation, and size from which more or less distinct subspecies may be recognized. By investigating this type of tiger beetle it is possible to obtain some correlation with recent geological history, to the extent that hypotheses can be advanced as to their former paths of dispersal with a fair chance of being accurate. *C. californica* and *C. willistoni* belong to this group. On the other hand the more ecologically tolerant tiger beetles, such as *C. hæmorrhagica*, cannot be studied with respect to these details. They are so well adapted to the conditions that prevail in the Southwest that they will disperse fortuitously whenever a new favorable condition arises.

On the assumption that Rivalier's regrouping of the *Habroscolimorpha* is correct, then the distribution of the species is confined mostly to the southern United States, Mexico, and Central America. These species nearly circumscribe the Gulf of Mexico, and inhabit the islands therein. While they do not populate the north shore of South America, they do spread northward along the Atlantic coast of the United States to Rhode Island. An offshoot branch populates the upper Sonoran Region, reaching as far as the shores of the Gulf of California, the Mojave - Colorado Deserts, and the Pacific coast of Southern and Baja California.

Cicindela prætextata is distributed in the Rio Grande system and the tributaries of the Colorado River. It reaches from southern Utah to the southern valleys of Arizona, and from western Texas to the lower Colorado River at Yuma, Arizona. It is present at the Salton Sea in California. *C. prætextata* is a distinct and polytypic species. This discussion will concern itself only with ssp. *erronea*.

1. *C. prætextata erronea* is found exclusively in the basin of ancient Lake Cochise in southeastern Arizona. It discloses a case of

entrapment dating at least from an "earlier" pluvial period. There is no evidence that Lake Cochise was ever connected to the Gila River, or even the Yaqui River, in pluvial times (Hubbs and Miller 1948: 115). The divides that now separate Lake Cochise basin from these river systems are low enough to allow fortuitous dispersal, however this is not occurring, either because of effective isolation, or because the exchange rate is so low and infrequent as to be absorbed; adaptability to a special environment may also be a factor.

The presence of ssp. *erronea* around a saline lake bed is an exception rather than a rule with *C. prae-textata*. This may explain the striking bright green and blue color of this subspecies as compared to the reddish bronze color of the other subspecies. To reach this state of development required long isolation in this environment, and this long period of time correlates remarkably well with the recorded isolation of Lake Cochise.

The distribution of *Cicindela californica* is restricted to the perimeter of the Gulf of California, the Salton Sea region, the Mojave Desert, and Death Valley. This species always frequents tidal marshes and saline lake shores. It is found at low elevations, from sea level to about 1000 feet (Koehn Lake, California, is the only known location where it reaches an elevation of 1900 feet), and below sea level at the Salton Sea (-235 ft.) and Death Valley (-260 ft.). This discussion will concern itself with the two subspecies found in the United States.

1. *C. californica mojavi* of the Colorado River delta region is characterized by a bronze color that is slightly tinged with green, and a broad maculation that tends to be confluent. It is present at Cholla Beach, Sonora (Vaurie 1953: 80) and San Felipe, Baja California (Cazier 1954: 289), and by the Salton Sea in Imperial and Riverside counties, California. It probably spread northward along the Colorado River banks from where it reached the Mojave River basin by way of an early pluvial discharge (Hubbs and Miller 1948: 90). It is possible and most likely that it reached the type location at Koehn Lake, Kern county, California, from the Mojave River region either through lake discharge (Hubbs and Miller 1948: 88), fortuitously over low divides, or by short flights across stream headwaters. The typical population is characterized by a maculation that is nearly always confluent, and a high percentage of green and blue individuals. It is now entrapped in the Koehn Lake basin with little or no hope of further dispersal under present conditions. The separation of the Koehn Lake population from the population of the upper Gulf of California coast since an early pluvial time accounts for the differences in width of maculation between the two groups.

2. *C. californica pseudoerronea* has a bright green and blue color and a reduced maculation. This indicates a long and isolated tenure in Death Valley, where tiger beetles show a trend toward such de-

velopment. The presence of *C. californica* along the Mojave River in pluvial times does not account for the Death Valley subspecies since this would be predicated on ssp. *pseudoerronea* being directly derived from ssp. *mojavi*. It is unlikely that ssp. *pseudoerronea* reached its present state of development since the time of the relatively recent pluvial flow of the Mojave River into Death Valley. A still "earlier" connection with the Gulf of California is indicated.

At Soda Lake in San Bernardino county, near Baker, California, there is a hybrid population of *C. californica mojavi* X *pseudoerronea*. Individuals of this population are bright green and blue except for 15% that are bronze with only a greenish tinge. Their maculation is broad to confluent. Their size is smaller than either ssp. *pseudoerronea* or ssp. *mojavi*, measuring on the average 10.0 mm for males and 10.9 mm for females, based on sample sizes of 16 for each sex.

Soda Lake is the present sump of the Mojave River. The lake bed is normally dry except for a few small spring fed areas at the western edge. Around these areas four or five species of *Cicindela* may be found. The location of this lake is some distance north of the probable early pluvial discharge of the Mojave River into the Colorado River; it is, however, in the direct path of a chain of lakes through which the Mojave River discharged into Death Valley in pluvial times. The hybrids at Soda Lake most likely represent a cross between bronze, confluent maculated, residual *mojavi* populations left along the Mojave River, and green, narrowly maculated *pseudoerronea* stock from Death Valley. This argument leads to a conclusion that favors the isolation of the Death Valley populations from a time that predates the known Mojave - Colorado River connection.

The gradation in color that is apparent from Death Valley to Koehn Lake is caused by dilution of the typical ssp. *mojavi* as a result of this recent contact with ssp. *pseudoerronea* at the discharge end of the pluvial Mojave River lake chain. This is borne out by the fact that typical ssp. *mojavi* from Koehn Lake are 40% green or blue, whereas ssp. *mojavi* from Mexico and the Salton Sea are all bronze or greenish bronze.

DESCRIPTION OF TYPE

Cicindela californica pseudoerronea, new subspecies

Medium size, slender, bright green and blue. HEAD - green on top, clypeus and sides blue; labrum provided with six setæ, front margin feebly tridentate, median tooth acute; eyes prominent; front with numerous shallow longitudinal striæ; vertex lightly wrinkled; joints three and four of the maxillary palpi pigmented, second joint pigmented only on the dorsal side. PROTHORAX - green and lightly wrinkled on disc; blue transverse impressions deep; sides arcuate, slightly more narrow at base than in front; recumbent white hairs sparsely distributed along the sides, and a few along the anter-

ior edge. ELYTRA — pigmented area bluish green; evenly punctate, very finely rugose between the punctures; punctures blue and shallower near apex; sides nearly parallel to apical fifth, then turning toward apex; suture toothed near apex; maculation white, completely connected along the outer edge, humeral lunule indicated by a thickening of the white border, central lunule descending obliquely, tip of apical lunule large and recurving toward the tip of the central lunule. LEGS — middle and anterior coxæ clothed with white recumbent hairs, hind coxæ glabrous; femurs blue, sparsely covered with white erect hairs; tibiae green; tarsi long and slender. UNDER-SIDE — head glabrous; thoracic sides green, color mostly hidden under dense long white recumbent hairs; last two abdominal sternites testaceous; the rest of the underside deep polished blue; sides of abdominal sternites, except last segment, clothed with white recumbent hairs. Male — length 11.8 mm, width 4.2 mm. Female — length 12.1 mm, width 4.6 mm.

TYPE LOCATION

Seven miles north of Furnace Creek, Death Valley, Inyo county, California. The elevation is 260 feet below sea level. At this location there are natural springs that drain in long shallow streamlets into the open alkali flats that constitute the drainage basin of Salt Creek. This area is wet from winter until mid-June, then the surface water dries up and only sub-surface moisture remains. Ssp. *pseudoerronea* occupies the area, in adult form, from the middle of April until June. A dead individual was found in November.

DISTRIBUTION

Death Valley, Inyo and San Bernardino counties, California. Aside from the type location there is another population at Saratoga Springs, 80 miles to the south. Here, they frequent the damp salt flats that make up the braided bed of the usually dry Amargosa River. This location, at 200 feet above sea level, is below the level of the high stage of Pluvial Lake Manly, therefore well within the valley from the entrance of the ancient Mojave River.

TYPE MATERIAL.

Holotype male, allotype female, in the author's collection; collected at the type location on May 7, and May 5, 1954, respectively. 303 paratopotypes collected on the following dates: April 10, 1954 (25), April 11, 1954 (8), May 7, 1954 (125), May 29, 1954 (22), May 31, 1954 (7), June 5, 1954 (Cazier 5), April 16, 1955 (3), April 23, 1955 (4), May 8, 1955 (27), May 18, 1955 (17), May 5, 1956 (15), April 28, 1957 (45). 91 paratypes from Saratoga Springs collected May 7, 1955 (75), May 19, 1955 (16).

Distribution of paratypes: 2 to the Death Valley National Monument in care of Mr. E. Floyd Keller, naturalist; 4 to Dr. O. L. Cartwright of the U.S. National Museum; 10 to Mr. Lloyd M. Martin of the Los Angeles County Museum; 11 to Mr. Hugh B. Lecch of the California Academy of Sciences; 8 to the Reverend Bernard Rotger of Pagosa Springs, Colorado; 6 to Mr. W. J. Brown of the Canadian Department of Agriculture; 5 to Mr. Darwin Tiemann of China Lake, California; 152 to Dr. Mont A. Cazier of the American Museum of Natural History. The remaining 196 are in the author's collection.

COMPARISON BETWEEN KNOWN POPULATIONS OF SSP. *PSEUDOERRONEA*

The populations from near Furnace Creek and Saratoga Springs are practically alike. In the latter the maculation is slightly broader, and the middle and apical lunules are nearly confluent in 6% of the individuals.

character compared	<i>C. prætextata erronea</i>	<i>C. californica pseudoerronea</i>
color	more individuals are green (74%)	more individuals are blue (58%)
maxillary palpi	1. pigmented at last segment, more so at tip. (joint overlap of 13%) 2. tip of last segment rounded	1. both last segments pigmented; 2nd joint pigmented dorsally 2. tip of last segment less rounded
elytra	evenly punctate all over	punctures more shallow near apex
maculation	1. generally narrower 2. central lunule usually descends toward apical; widest at middle	1. generally wider, especially so in the Saratoga Springs population 2. central lunule more ablique, ends further away from apical
prothorax	white hairs at both top and bottom edges, sometimes an disc	less hairs at top edge, usually none at bottom edge, none an disc
underside	all abdominal sternites pigmented	last and often penultimate sternite testaceous

Table A

Minor points of difference between ssp. *erronea* and ssp. *pseudoerronea* (exclusive of sexual differences)

Subspecies *erronea* is slightly longer than ssp. *pseudoerronea* as shown in Table B. This difference is not significant, and is too small to be readily noticed. That ssp. *erronea* is larger is in keeping with the greater size of ssp. *prætextata*.

COMPARISON WITH NEAREST RELATED SUBSPECIES

The main difference between ssp. *pseudoerronea* and its nearest relative *C. californica mojavi* is in the color and width of maculation. In ssp. *pseudoerronea* the color is always bright green or blue, and the maculation is relatively narrow, whereas in ssp. *mojavi* from Koehn Lake less individuals are green or blue, and in all cases the maculation is either broad or actually confluent. (Refer to Plate 32, figs. i, p, and q).

 CHARACTERS RELATING
 SSP. *PSEUDOERRONEA* TO *C. CALIFORNICA*

That *pseudoerronea* is a subspecies of *C. californica* is recognizable by the general appearance, the maculation pattern, and especially by the primary sexual characters of the male. A typical penis of ssp. *pseudoerronea* is illustrated in Plate 32, fig. e; it is similar to the penis of other subspecies of *C. californica* in that the middle lobe is bulbous and the neck is comparatively thick. Figs. b, f, k, and o in Plate 32 illustrate the internal sacs of the *C. californica* subspecies; in ssp. *pseudoerronea* the membrane sustained by the flagellum is sometimes folded forward as shown in fig. o. A secondary sexual character represented by the penultimate abdominal sternite indicates that in *C. californica* the penial notch is deep, evenly curved, and the space separating it from the 5th sternite is relatively narrow.

 CHARACTERS RELATING
 SSP. *ERRONEA* TO *C. PRÆTEXTATA*

That *erronea* is a subspecies of *C. prætextata* is more difficult to recognize by any feature of the facies, however the sex characters of the male readily reveal the relationship. The penis has a slender neck that expands evenly to the median lobe, and the internal sac is of the *C. prætextata* type as illustrated in Plate 31, figs. b and e. The penultimate abdominal sternite has a shallow penial notch, with a relatively wider space between the base of the notch and the 5th sternite.

subspecies	population	sample size			longest (mm)	shortest (mm)	average length			s
		n	♂	♀			\bar{x}	\bar{x} ♂	\bar{x} ♀	
<i>prætextata</i> <i>erronea</i>	Willcox, Ariz.	20	10	10	13.4 ♀	11.0 ♂	12.1	11.9	12.3	.67
<i>californica</i> <i>pseudoerronea</i>	Furnace Creek	20	10	10	12.7 ♀	10.9 ♂	11.9	11.7	12.0	.43

Table B

Comparison of length between ssp. *erronea* and ssp. *pseudoerronea*.

COMPARISON BETWEEN
SSP. *ERRONEA* AND SSP. *PSEUDOERRONEA*.

Subspecies *erronea* and *pseudoerronea* are obvious siblings. They are so similar in appearance that it would be difficult to correctly identify all of the individuals if they were mixed indiscriminately.

Plate 31, fig. h of ssp. *erronea* and Plate 32, fig. i of ssp. *pseudoerronea* attempt to illustrate generalizations of the maculation that may be noticed in large series. Ssp. *erronea* has a middle lunule that usually extends downward toward the apical lunule. In ssp. *pseudoerronea* the middle lunule usually extends obliquely, and sometimes bears a slight bulb at the tip. Table A lists some minor points of difference.

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